Fenlow

DIGITAL VOLTMETER

PLUG-IN TYPE C

MP MASTER
MA23401

Penley

DIGITAL VOLTMETER

PLUG–IN TYPE C

(D.C. VOLTAGE– MANUAL, COMMAND
AND AUTO. RANGING)

INSTRUCTION MANUAL

FENLOW ELECTRONICS LIMITED,
JESSAMY ROAD,
WEYBRIDGE,
SURREY,
ENGLAND

TELEPHONE: WEYBRIDGE 43978

JUNE 1969

DO NOT ADJUST ANY POTENTIOMETER ON THIS INSTRUMENT BEFORE REFERRING TO SECTION FOUR.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_05854

CONTENTS

		Page No.
SECTION 1	SPECIFICATION	i
SECTION 2	OPERATING INSTRUCTIONS	1
SECTION 3	TECHNICAL DESCRIPTION	3
3.1	General	3
3.2	Grounded Components	3
3.3	Floating Components	5
SECTION 4	ADJUSTMENTS	7
4.1	Procedure	7
4.2	Zero adjustment on the 10 volt range	8
4.3	Zero adjustment on the 0.1, 1.0, 100 and 1000 volt range	8
4.4	Input Balance and Accuracy	9
4.5	Cal. Check	10
4.6	Factory Service	10

DIAGRAMS	Fig. No.
Command Range Charge Timing Waveform	51
Simplified Block Schematic Diagram	52
CIRCUIT DIAGRAMS	
Plug-in Type C	53
Grounded Range Logic	54
Floating Range Logic	55
ASSEMBLIES	
Plug-in Type C	56

1. SPECIFICATION FOR DVM TYPE 501-C

The specification is generally the same as that with the plug-in type A, except that instead of the X5 facility on the 0.1 volt range a X4 on the 0.1 volt range has been provided.

VOLTAGE RANGES

Range (1) 0 - 0.1 volt

Range (2) 0 - 1.0 volt

Range (3) 0 - 10 volts

Range (4) 0 - 100 volts

Range (5) 0 - 1000 volts

Range (6) 0 - 0.1 volt X4 (0.025V)

On Command and Auto Ranging the input voltage must not exceed 500V D.C.

2. OPERATING INSTRUCTIONS

MODES OF OPERATION

There are three ways of selecting the voltage ranges, manual, command and auto.

MANUAL

The unit operates manually by pushing one of the six range buttons.

COMMAND

This mode is obtained by commanding the three inputs on the rear connector, Fig.1 (DVM 501-A manual) by the code as shown below;

RANGE CODE

VOLTAGE RANGE	A(1)	B(2)	C(4)
0.1 volt	0	0	0
1.0 volt	1	0	0
10 volts	0	1	0
100 volts	1	1	0
1000 volts	0	0	1
0.1 volt X 4	1	0	1

Where

'0' state is to be less than +0.5 volt at 3.5 milliamps.

'1' state is to be between +3.0 volts and +5.0 volts at 5 milliamps.

A timing waveform diagram showing the point of range change is shown in Fig.51, waveform (1). The range code must be set up before or at the time of the trailing edge of the 'analogue complete' pulse (Fig.1 DVM 501-A manual) and it must last until 50 micro-seconds after the above trailing edge.

NOTE. On command the voltage range switches are over-ridden.

AUTO

When the auto button is pressed the DVM operates automatically, so that the reading shown lies between 01000 and 13999, except for the 0.1 and 1000 volt ranges where the reading can be below 01000 and above 14000 respectively.

NOTE. On auto range (6) is not used. Range changes occur approximately 200 microseconds after the transfer to store.

The shortest time between two range changes is 2 mains periods, equal to 40 milliseconds for 50 Hz mains frequency. If the DVM is on the 1000 volt range and the input voltage is changed so that the range required is the 0.1 volt, the longest time required to get to the 0.1 volt range is 5x2 mains periods, equal to 400 milliseconds for 50 Hz mains frequency.

NOTE. On auto the voltage range switches or command signals are over-ridden.

3. TECHNICAL DESCRIPTION

3.1 GENERAL

Figure 52 shows the basic operation of the plug-in type C.

This plug-in consists of grounded and floating parts which are connected using three pulse transformers, similar to those used in the DVM type 501.

Basically the grounded part consists of a three way switch, the positions of which are named manual, command and auto; with connections to the range switch on manual, to the rear connector on command and to a reversible counter controlled by the DVM reading on auto. The wiper of this switch drives a pulse transformer and sets three floating bistables which are reset as determined by the mode switch. From these bistables decoding circuits drive various reed relays to control the scaling on the Input Amplifier.

3.2 GROUNDED COMPONENTS

This description should be read in conjunction with the grounded range logic circuit diagram Fig.54.

On manual or auto the resets for the floating bistables occur at the time that the counters are reset, which is approximately 200 microseconds after the transfer to store. On command the reset occurs at the time of the trailing edge of the analogue complete pulse. When the reset pulse occurs this drives the pulse transformer T6 and triggers a 20 microsecond monostable, the trailing edge of which switches VT1 off

for about 5 microseconds, which removes the gating on three NAND gates that drive the pulse transformers. The other input of these gates is controlled by the mode switch. Only if the input is at a logical '1' does a pulse go through to the appropriate pulse transformer. The mode switch also drives the decimal point NOR gates which drive the decimal point neons on the counter board Fig. 14 (DVM 501-A manual).

For manual operation the code is set up by the voltage range switches.

For command operation the code is set up by the three input wires on the rear connector Fig.1. (DVM 501-A Manual).

For auto operation the code is set up by a reversible counter, a synchronous 124 BCD counter, where 101 to 111 are redundant states.

For up shifts:

If the output of the 14000 Pulse Gate goes to a logical '0', then this sets a bistable whose outputs control the reversible counter to count up when a clock pulse is received. When 14000 is detected, it removes the inhibit on a NAND gate, so that when the Delay Reset Monostable output Fig.13 (DVM 501-A Manual) goes to a logical '1', a positive pulse is applied to the clock pulse terminals. At the time of the trailing edge of the Delay Reset Monostable the clock pulse line goes back to a logical '0' and thus the reversible counter counts up one state. The trailing edge of the clock pulse also resets the above bistable.

For down shifts:

If at the time of the leading edge of the Delay Reset Monostable the output of the 00999 Pulse Gate is at a logical '0', then the clock pulse line goes to a logical '1' and returns to '0' at the time of the trailing edge of the Delay Reset Monostable. As the above bistable was in the reset state, the clock pulse causes the reversible counter to count down one state.

3.3 FLOATING COMPONENTS

This description should be read in conjunction with the floating range logic and plug-in type C circuit diagrams Fig.55 and 53 respectively.

The reset pulse that drives the pulse transformer T6 triggers a 10 millisecond monostable, the output of which switches VT1 on for about 5 microseconds thus resetting the three floating bistables.

NOTE. The fact that the reset pulse also triggers A(1) bistable to the set state is over-riding as the reset pulse from VT1 is much longer.

Approximately 20 microseconds later when the coded pulse appears and the bistables A(1), B(2) and C(4) are set according to the above code, the 10 millisecond monostable is not retriggered as it has not returned to its normal state; thus VT1 stays off. The outputs of the above three bistables are decoded and drive the relay buffers VT3 to VT7 according to the above code. The reed relays switch in the appropriate

feedback resistors around the input amplifier and the attenuator resistors.

4. ADJUSTMENTS

CAUTION

After switching on the supplies, allow the DVM one hour to reach its operating temperature. If after one hour the instrument is not performing according to its specification only the following adjustments may be attempted.

4.1 PROCEDURE

SWITCH ON AND ALLOW THE INSTRUMENT TO REACH ITS OPERATING TEMPERATURE

Short the three input leads (High, Low and Guard) together. If the instrument fails to read zero on the following ranges, refer to the sections shown:

a) 10 volt range - see section 4.2.

b) 0.1, 1.0, 100 or 1000 volt range - see section 4.3.

c) 0.025 volt range - see section 4.3f

If it is required to test the accuracy, this is done in two stages. First the Input Balance is checked to ensure that the voltage of an external cell gives the same reading when its polarity is reversed. Secondly the absolute calibration is checked by means of an external standard cell. Both these procedures are described in section 4.4.

The internal facility for Calibration check may then be adjusted so that it is thereafter available for spot checking of the instruments accuracy. See section 4.5.

4.2 ZERO ADJUSTMENT ON THE 10 VOLT RANGE

Short together all three wires of the DVM input lead. Select Manual and the 10 volt range, select Internal Interrogate, all other push buttons on the DVM to be released. With a suitable screwdriver, unlock the Dzus fasteners at the rear of the top cover of the DVM. Slide the cover towards the rear of the instrument until it is possible to lift the cover from the DVM frame. Insert a small screwdriver through the hole labelled RV3 in the top screen of the rear floating unit, to gain access to the 10 volt range zero adjusting potentiometer. Adjust this potentiometer to make the DVM reading approach zero; the final critical adjustment must make the sign indicator tube change from + to - or vice versa. ("Randomly changing sign"). The indication on the 10 volt range should then be zero $\pm$ 1 digit.

Replace the top cover and secure the Dzus fastener.

4.3 ZERO ADJUSTMENT ON THE 0.1, 1.0, 100 and 1000 VOLT RANGE

a) Verify that the DVM complies with section 4.2.

b) Select 100 volt range. Open circuit the Input high lead and adjust the current potertiometer labelled I on the front panel until the DVM indicates randomly changing sign.

c) For a fine adjustment of the current potentiometer, select the 0.1 volt range and press the Filter button. With the input lead still open circuit readjust the current potentiometer to minimise the rate of change of DVM reading with time.

d) Short circuit all three input leads of the DVM and release the Filter button, then adjust the voltage potentiometer labelled V on the front panel until the DVM indicates randomly changing sign.

e) Repeat (c) and (d) alternately until correct indications are obtained for both adjustments.

f) For use on the 0.025 volt range it is permissible to readjust the Voltage Potentiometers to give randomly changing sign when the input leads are shorted together. Provided that the adjustments of (c), (d) and (e) have been carried out, only a very small readjustment, equivalent to less than 5 digits, will be required. This will have no adverse effect on the other ranges.

4.4 INPUT BALANCE AND ACCURACY

a) Verify that the DVM successfully fulfils section 4.2 and 4.3. A standard cell of the following specification will be required in order that the following part of the procedure may be accomplished: 1.0185 - 1.0192 volts with a temperature coefficient of not greater than 5 microvolts per degree centigrade.

b) Select the 1.0 volt range. Connect Input high to the standard cell +ve terminal and Input low to the standard cell -ve terminal. Connect the Guard lead to Input low. DVM should indicate the cell voltage ± 5 digits and display a positive sign.

RECORD THIS READING.

c) Reverse the connections to the standard cell from the DVM input lead (Guard still connected to Input low). The DVM should indicate the cell voltage ± 5 digits and display a negative sign.

d) Compare this reading with that recorded in (b), subtract the magnitude of the two readings and note the difference.

e) By adjusting the Input Balance potentiometer on the front panel, increase or decrease as is appropriate the DVM indicated reading by half the above difference.

f) Repeat (d) and (e) until the DVM reading of the cell voltage is the same for either sign.

g) To obtain absolute calibration of the instrument, adjust the Cal. Scale potentiometer on the front panel until correct indication of the standard Cell voltage is reached.

4.5 CAL. CHECK

a) Verify that the DVM complies with Sections 4.2, 4.3 and 4.4.

b) Remove the top cover as detailed in section 4.2.

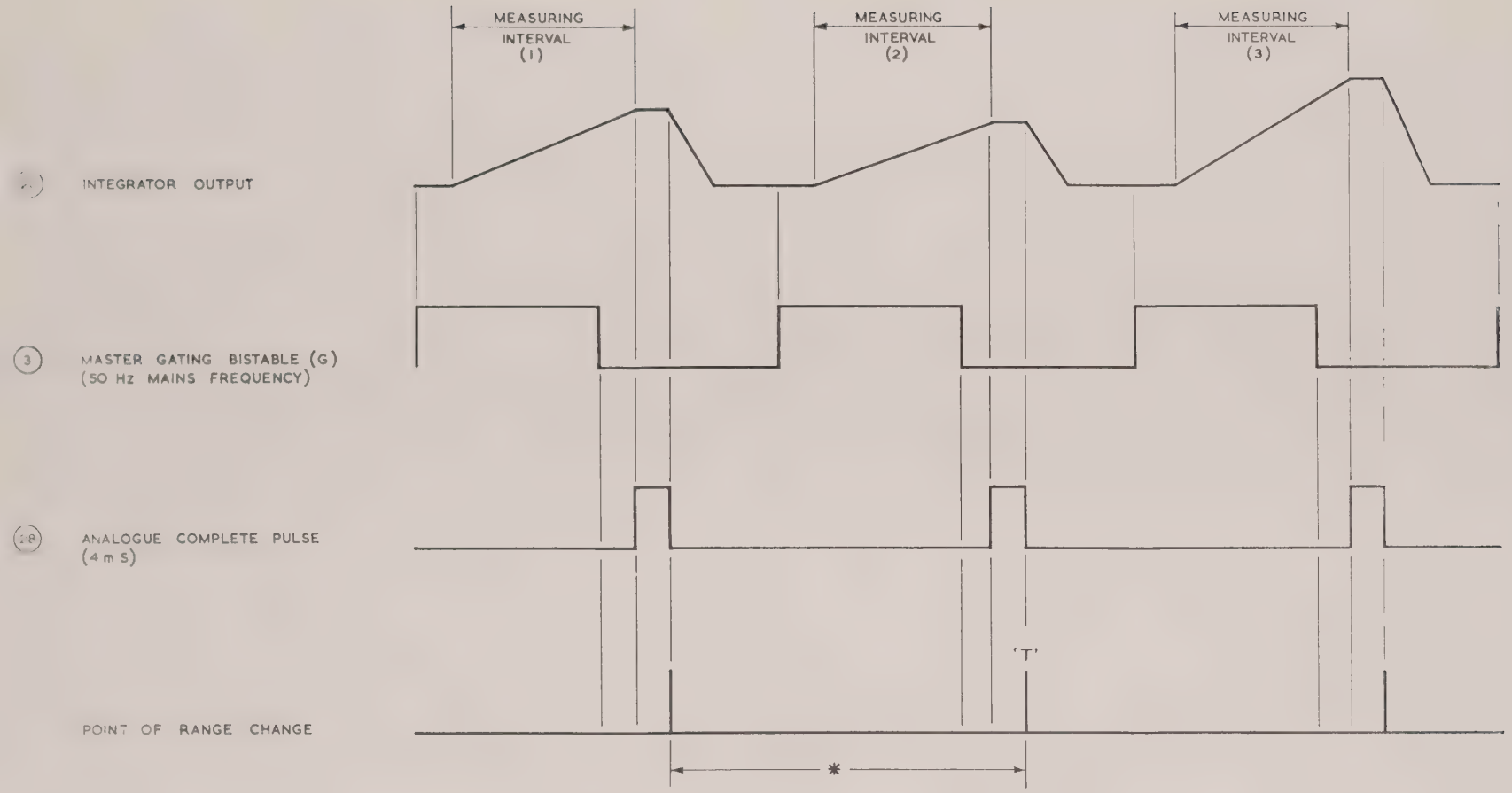
c) Press the +ve Cal. Check button, note the DVM reading and use a suitable screwdriver to adjust RV4 until the DVM reads 1.0000. The potentiometer is accessible through a hole labelled RV4 in the top screen of the front floating unit.

d) Press the -ve Cal. Check button and confirm that the -ve Cal. Check reading does not differ from the +ve Cal. Check reading by more than 1 digit.

4.6 FACTORY SERVICE

If the DVM has symptoms other than these covered in this Adjustment Procedure or this procedure is not sufficiently effective in a particular case, refer to Fenlow Electronics Ltd., or their Agents. If standardization equipment and staff are

available, a full adjustment and calibration procedure can be obtained from Fenlow Electronics Ltd., or their Agents.

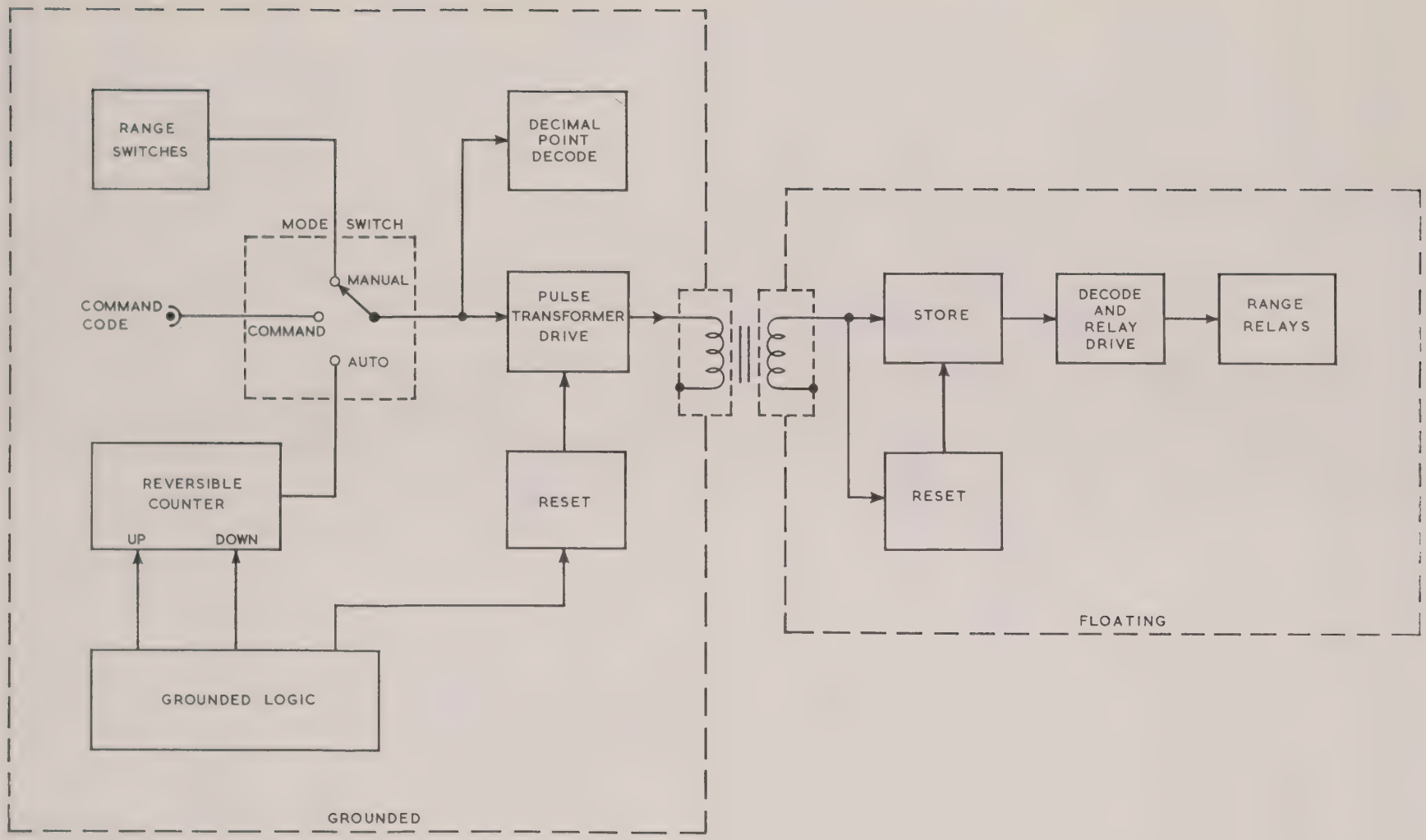


* TIME FOR APPLICATION OF CODE FOR RANGE CHANGE AT 'T'. CODE MUST BE MAINTAINED UNTIL 50 MICROSECONDS AFTER TIME 'T'. THE RANGE CHOSEN IS FOR MEASURING INTERVAL (3)

NOTE. FOR WAVEFORMS 3, 20 & 28 SEE FIG. 8 & 9 DVM 501-A MANUAL

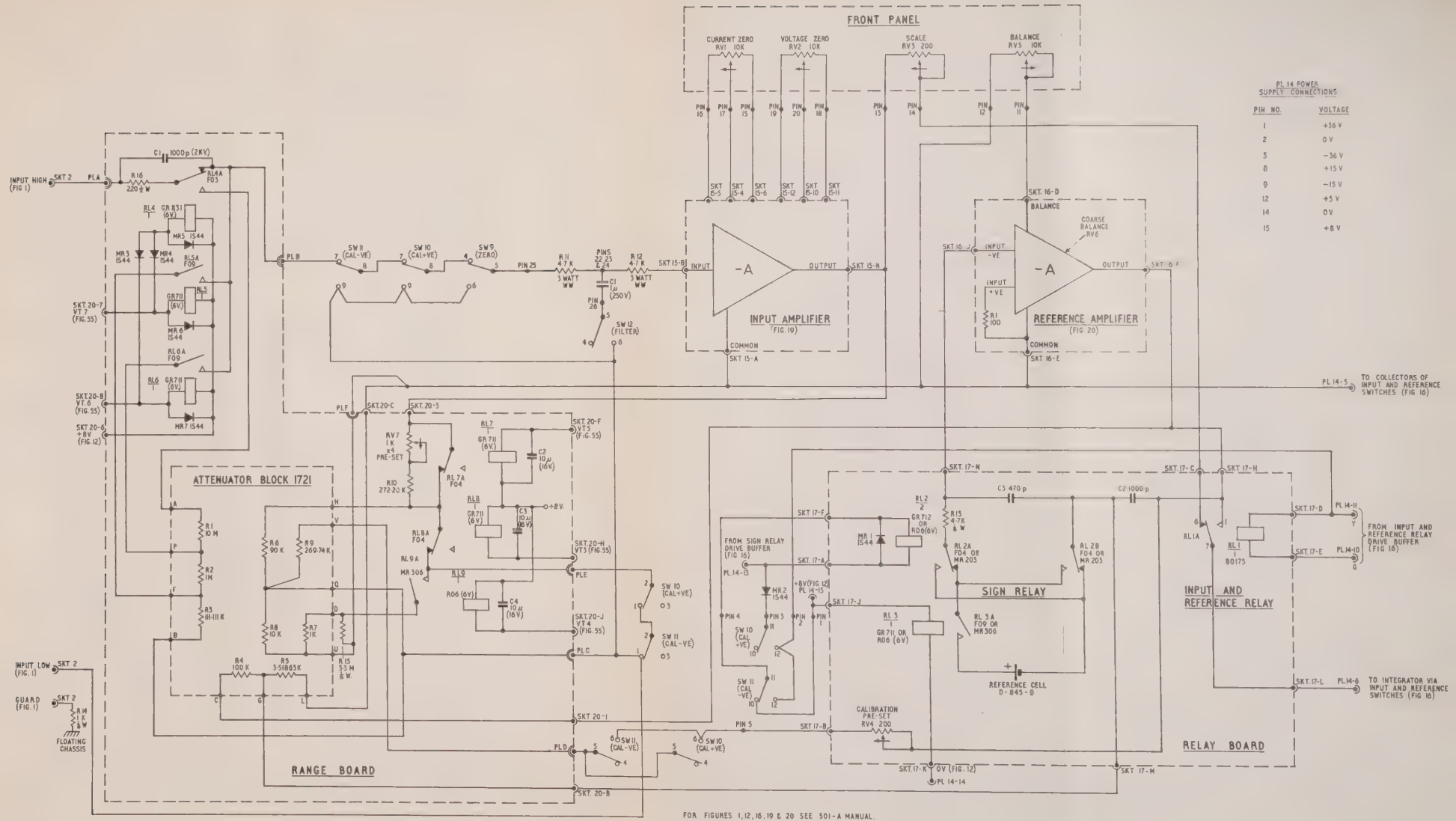
COMMAND RANGE CHANGE TIMING WAVEFORM DIAGRAM

FIGURE 51.



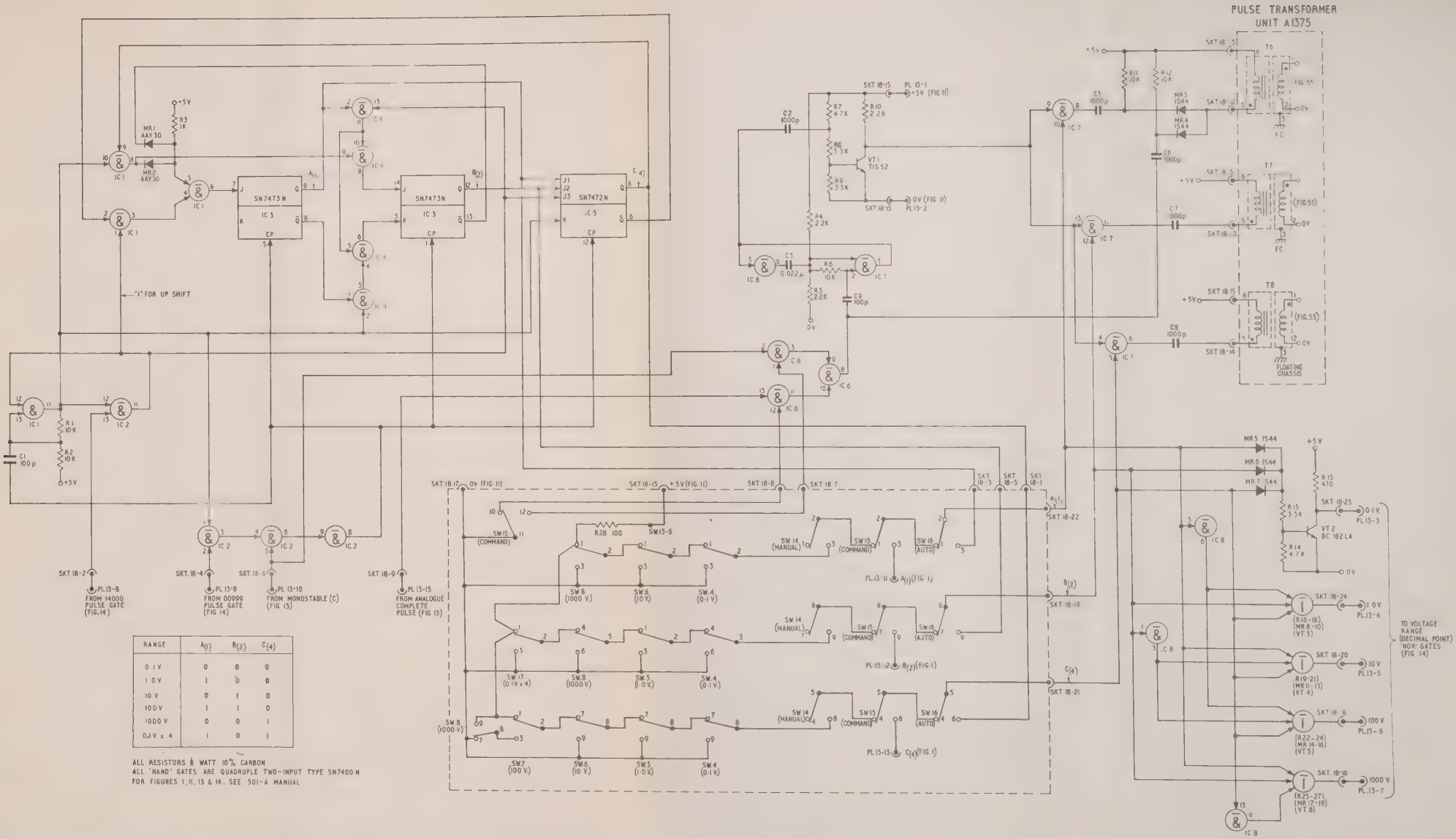
SIMPLIFIED BLOCK SCHEMATIC DIAGRAM

FIGURE 52.



D V M PLUG-IN TYPE C CIRCUIT DIAGRAM

FIGURE 53.

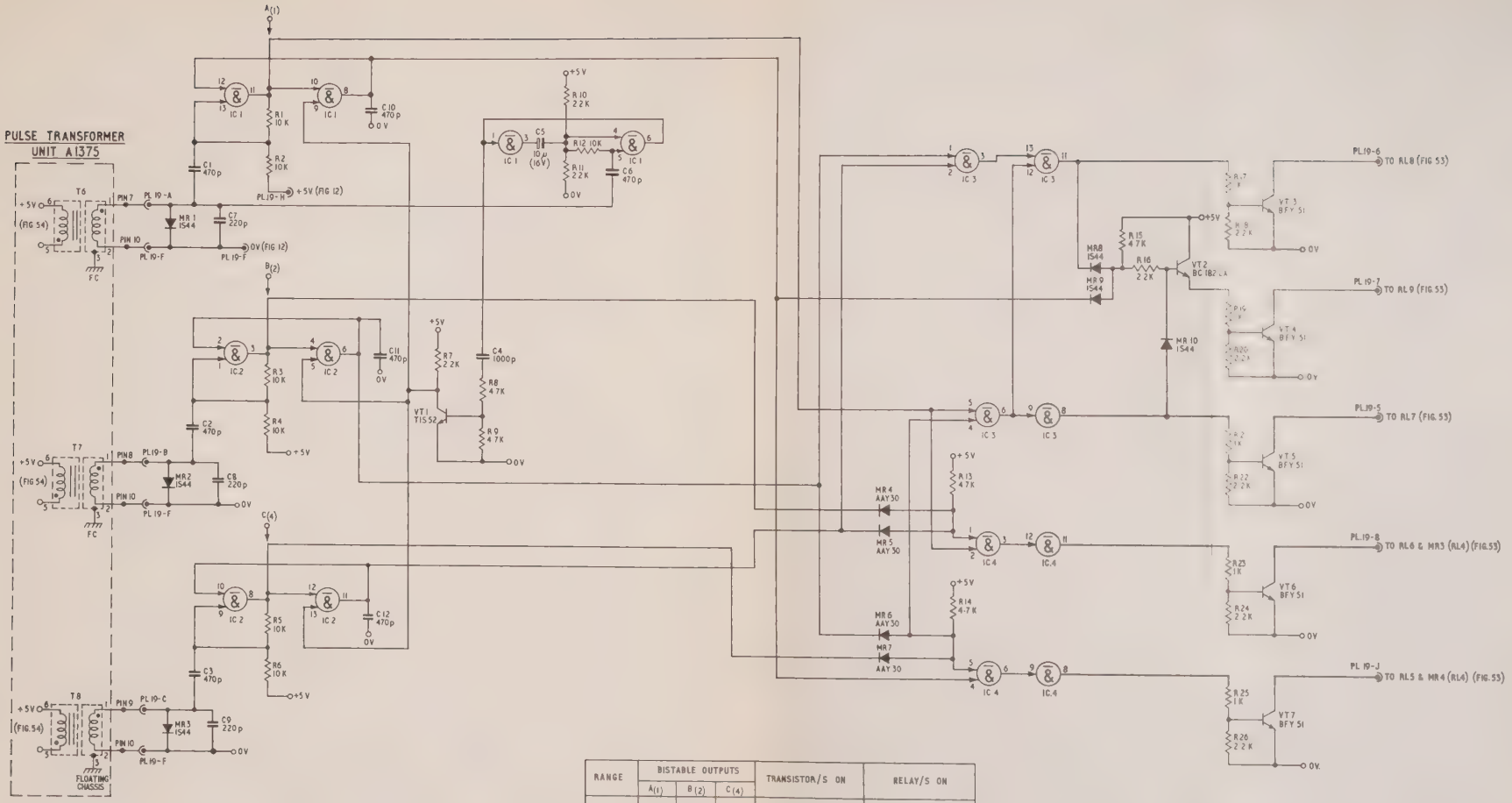


RANGE	A(1)	B(2)	C(4)
0·1 V	0	0	0
1·0 V	1	0	0
10 V	0	1	0
100 V	1	1	0
1000 V	0	0	1
0·1 V x 4	1	0	1

ALL RESISTORS ¼ WATT 10% CARBON
ALL 'NAND' GATES ARE QUADRUPLE TWO-INPUT TYPE SN7400 N
FOR FIGURES 1, 11, 13 & 14, SEE 501-A MANUAL

D.V.M. PLUG-IN TYPE C GROUNDED LOGIC CIRCUIT DIAGRAM

FIGURE 54.

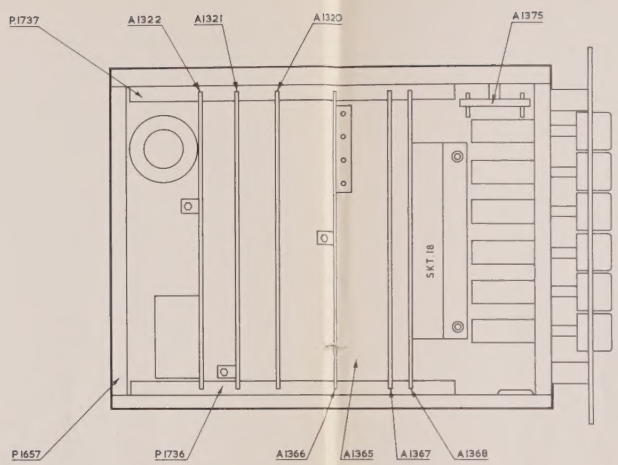


RANGE	BISTABLE OUTPUTS			TRANSISTOR/S ON	RELAY/S ON
	A(1)	B(2)	C(4)		
0-1V	0	0	0	VT3 & VT4	RL 8 & RL9
1-0V	1	0	0	VT3	RL8
10 V	0	1	0	NONE	NONE
100V	1	1	0	VT6	RL4 & RL 6
1000V	0	0	1	VT7	RL4 & RL5
0-1V x 4	1	0	1	VT3, VT4 & VT5	RL7. RL8 & RL9

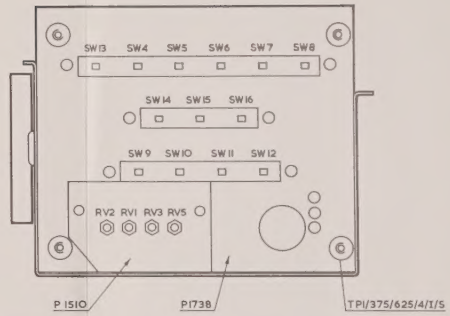
ALL RESISTORS ¼ WATT 10 % CARBON
ALL 'NAND' GATES ARE QUADRUPLE TWO-INPUT TYPE SN7400N
FOR FIGURE 12 SEE 501-A MANUAL

DVM PLUG-IN TYPE C FLOATING RANGE LOGIC CIRCUIT DIAGRAM

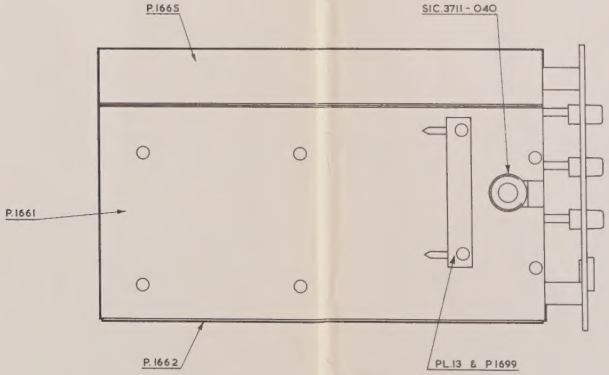
FIGURE 55.



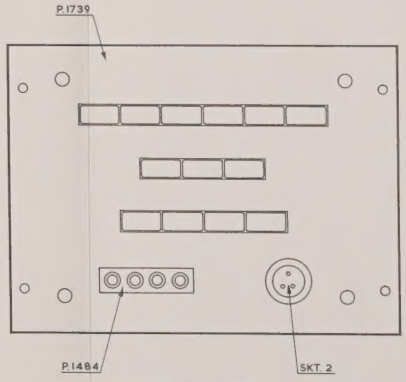
PLAN VIEW



FRONT VIEW WITH FRONT PANEL REMOVED



SIDE VIEW



FRONT VIEW

PLUG-IN TYPE C GENERAL ASSEMBLY (A1364)

FIGURE 56.

MP MASTER
MA23401